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Research Note

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X FACTORS CONTRIBUTING TO THE 1953 FLOODS IN THE VICINITY OF GREAT FALLS, MONTANA X

C. Allan Friedrich
Division of Flood Control Surveys

Like many catastrophies, the \$5,220,000 flood which occurred in June in the vicinity of Great Falls, Montana, produced some valuable lessons that will help us reduce the chances for future losses. Systematic measurements before and after the heavy rains which fell May 24 to June 3 are not available. Observations made as the flood waters were receding, however, show clearly some of the basic causes of damage and reasons for the flood developing.

The Situation

On April 1 measurements in the Sun River area showed that the snow pack contained less water than had been measured in the previous four or five years. Six snow courses gave average water contents of 10.0 inches as compared to the 13.9-inch average of the previous four years, or 13.1 inches for the five-year average including 1953. Snow melt at higher elevations was retarded during April and May but there was little indication that melt was unusually heavy during late May or early June. The weather during the flood period was abnormally cool. Hence, there seems little to indicate the flood was intensified greatly by snow melt.

Extremely heavy rains began falling May 24 in an area centered in the Highwood Mountains east of Great Falls. During the 11-day period May 24 to June 3 the official U. S. Weather Bureau records show precipitation totaled:

Shonkin	18.79 inches
Great Falls	9.90 "
Sun River	7.72 "
Augusta	7.03 "

Some rain occurred practically every day throughout a large area. Rainfall generally was not of the torrential or cloudburst type but high intensities may have occurred locally. The highest intensity recorded officially was 0.07 inch in five minutes or 0.84 inch per hour at Great Falls. At Shonkin, where more than 6.5 inches of rain fell in a 24-hour period on two occasions, it is probable that rather high intensities may have been reached there for short periods.

Much of the runoff water, especially from the high forested land, resulted from rapid return flow from saturated soil. This came as seepage flow at a steady rate and was augmented at times, especially in the foothill and plains area, by more rapid surface runoff following periods of heavier rainfall. As a result, all feeder streams were running at least bankfull and the natural scheduling of runoff which ordinarily protects the secondary streams from flooding by snowmelt or local cloudburst type storms, was ineffective.

The Results

Of course, great damage was done to homes, industrial plants, roads, bridges, and other structures. Serious damage, not reflected in the estimate previously given, was also done to the stream channels and to the soil. While there was little evidence of surface runoff and sheet erosion from the higher forested lands, moderately severe sheet and shoestring gully erosion was common on bare cropland and on heavily grazed range lands. Channel scouring, bank cutting, and deposition of debris of all kinds constituted the greatest damage.

Debris was a major factor causing damage in headwater areas. Beaver dams, logging slash, fire- and disease-killed trees, mining waste, road fills, abandoned mill ponds, inadequate culverts, and bridges all worked together in restricting the orderly flow of an unusually large amount of water.

Damage resulted from a series of chain reactions. Debris in a small stream temporarily built up a head of water. The obstruction then gave way and the rush of water picked up additional gravel and debris. A bridge or culvert downstream was soon clogged and a larger head developed. A series of breaks and crests progressed, each worse than the one before. As these supplemented one another in the converging water courses, large structures were swept away and excessive channel washing occurred.

In many places where large amounts of soil and rock were washed into a stream, the channel now is extremely shallow relative to bank height. Lesser volumes of water in the future will overflow onto adjacent land. New gravel bars have been deposited which are diverting streams against raw banks. This situation will continue to add debris to the channels as trees topple over and the soil is washed downstream.

Channels in many of the small and medium sized streams were so badly damaged that we can expect far greater property damage from less water in the future. The system will not be able to handle runoff because of channel changes including gravel deposits, debris dams, and unstable banks.

Lessons Learned

Certain things stand out from the observations of damages in the Great Falls region that point to better practices, especially in the headwater areas. Most forest managers and engineers already know of these practices, which, if followed, will prevent much future flood damage. The following list, therefore, may serve to emphasize the things that should be done to the fullest extent possible.

1. Keep debris out of channels. Logging slash and the natural windfall

of dead trees constitutes a real threat to stream stability during high water periods. Debris that has become part of a stabilized channel should not be removed.

2. Avoid infringement of roads on streams. Straightening a channel along a forest road or highway by rerouting the stream and constructing fills is asking for trouble. This practice usually speeds up the flow in a channel that already has a steep gradient. Bank cutting and degrading takes place in the straightened reach and the material is deposited at the foot of the run where a braided channel and further cutting and meandering develops.

3. Culverts must be large enough to accommodate peak flows. Damage to relatively new highways occurred in the Great Falls area because of inadequate culverts.

4. Channels under bridges must be adequate and bridge piers must be so constructed and placed to minimize plugging by debris in high water periods.

5. Road fills, especially at stream crossings, must be adequately stabilized to prevent washing.

6. Better land use practices -- fire protection, moderate grazing, and intelligent logging methods -- can all help to prevent rapid runoff, maintain high infiltration rates, and generally minimize the effects of critical high water periods.

Above all, forest managers should learn to spot the formation of each potential chain reaction condition as it develops on a headwater stream, and take corrective action before it is too late to remedy the situation.

